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RESTORATION OF SKELETAL MUSCULATURE

Prof A. N. Studitskiy

[Comment: In the following article, Prof A. N. Studitskiy, head of the laboratory, Institute of Animal Morphology imeni A. N. Severtsov, Academy of Sciences USSR, briefly summarizes his research and experiments. Studitskiy and A. R. Striganova, senior scientific associate of this institute, were among those honored by the award of a Stalin Prize for outstanding work performed in 1951. The award was bestowed for the scientific work entitled "Restoration Processes in the Skeletal Musculature," published last year.]

The problem of utilizing tissues in the restoration of lost or damaged organs has been occupying the minds of scientists for the past 200 years. During this time it was discovered that some animals possessed the amazing ability to restore the lost part of their bodies from small pieces of their tissues. The minute fresh-water organism the hydra, an inhabitant of ponds and rivers, can easily restore its entire body from a small piece of its tissues. A rainworm cut into ten pieces becomes ten rainworms.

The ability to restore lost parts has been discovered in both lower and higher animals. The salamander, an inhabitant of fresh water, or the axolotl grown in an aquarium, can restore a paw, a tail, jaws, or eyes which have been cut off. A lizard can restore a torn-off tail. Yet these animals are vertebrates.

During the past 50 years, under the influence of the pseudoscientific, idealistic Weismannism, biology followed the theory that a weakening of restorative powers had occurred in higher animals.

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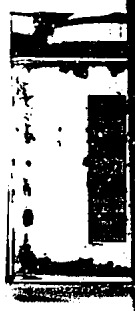

Many textbooks state that higher animals pay with the loss of their organic regenerative ability for the complexity of their structure, and for the perfection of their organs which are adapted to the performance of numerous functions unattainable by lower animals. It has been said that complexity of the structure of organs and tissues is an insurmountable obstacle to their restoration. It has been emphasized that the organism of a higher vertebrate animal, as well as that of a human, is unable to cope with damages to the complex tissue which makes up the muscular structure. Such theories handicapped science, and impeded the development of clinical surgical practice.

We approached the subject of the restoration of tissues and organs from an entirely new standpoint. Our previous experiments allowed us to draw the conclusion that complexity of structure is not an obstacle to the restoration of organs and tissues in higher animals. For instance, the organism of one type of higher vertebrate animal, the bird, can restore within the shortest time any extracted organ such as a clavicle, a hip bone, or any tubular bone of complex structure. In our laboratory we have preserved entire series of bones extracted from roosters on as many as four occasions. The organism of a rooster repeatedly restores and replaces the lost organ.

On removal of more than half the liver, this organ is replaced in higher vertebrate animals such as birds and mammals quicker and in a more perfect form than in lower vertebrates such as fish and amphibious animals.

Such were the facts which gave birth to the theory that the ability to replace and restore damaged tissues and organs has not decreased but has increased in higher animals.

Our further experiments fully supported this theory. In birds, muscular tissue, which possesses the highest degree of complexity, is restored with the greatest rapidity and completeness. If two thirds of the wing muscle lifting the shoulder of a young rooster is removed, within a month the space formed between the ends of the muscles will be filled with fresh muscle tisaue.

The ability to restore lost parts of muscles has been observed and noted in other vertebrate animals, namely amphibians and mammals.

The availability of material from which young muscular tissues will grow is of primary importance in the restoration of musculature. The removal of an entire muscle will preclude regeneration even in an axolotl, famous for its ability to restore entire extremities. Regeneration is achieved by means of utilizing the remaining part of damaged muscle tissue. We were able to create conditions favorable for the regeneration of muscles from remaining tissue. These included tension produced at the focal point of regeneration. The regenerating tissue must be stretched over the supporting structure. This is an essential requirement for further functional ability; without it the process of regeneration is impossible. The most important condition for the regeneration of muscles is the existence of a nerve connection to safeguard functioning of the restored muscle. Another essential factor is the condition of the connective tissue actively participating in the restoration process. Should dirt penetrate the wound, and inflammation set in, connective tissue would be involved in the process of inflammation, so that this tissue, developing rapidly at the focus of restoration, will interfere with the growth of regenerating muscle tissue. In such cases, scar tissue proliferates at the focus of regeneration, preventing the formation of new muscles.

The results of our experiments raise the question why the organism of higher animals, birds, mammals, and human beings, with its greater ability to restore lost tissues, is unable to restore an entire extremity, a feat which is so easily accomplished by the organisms of axolotls and newts?

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The answer is clear to any one who has kept an axolotl or a salamander in an aquarium. The extraordinary ability of regeneration in these animals is not accidental. Whenever these animals feel hungry, they start biting off each other's paws, tails, and other parts. The regenerative faculties of these animals are effectively adapted to compensate for the frequent loss of their organs. It seems logical that the higher vertebrate animals which are not subjected to frequent losses of extremities are deprived of the ability to restore them.

At the Histological Laboratory of the Institute of Animal Morphology imeni A. N. Severtsov, Academy of Sciences USSR, where our experiments took place, further experiments are being conducted on the restor[illegible]ive faculties of animal organisms. Our goal is to transfer the results of our experiments to a surgical clinic.

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